WHAT IS CLAIMED IS:

1. A method of manipulating cells suspended at an interface between an electrode and an electrolyte solution, the method comprising the following steps:

providing a plurality of cells suspended at an interface between an electrode and an electrolyte solution, the electrode being a light-sensitive electrode;

generating an electric field at the interface; and

illuminating the interface with a predetermined light pattern to control the movement of the cells in accordance with the predetermined light pattern and the properties of the electrode.

2. The method of claim 1, in which the movement of the cells is controlled by the combination of illumination and the electric field.

3. The method of claim 1, wherein the electric field is generated by application of an AC voltage.

4. The method of claim 1, further comprising the step of varying the configuration or the intensity of the light pattern.

5. The method of claim 1, wherein the properties of the electrode comprise the properties affecting the local distribution of the interfacial electric field.

6. The method of claim 5, wherein the properties of the electrode comprise impedance or surface charge depositing.

7. The method of claim 1, wherein the properties of the electrode comprise impedance, the modification in the impedance causing the cells to move to the area of low impedance in response to the electric field.

8. The method of claim 1, wherein the electrode comprises a silicon electrode which is coated with a dielectric layer.

9. The method of claim 1, which provides an additional electrode, the additional electrode and the light-sensitive electrode being substantially planar and aligned parallel to one another and separated by a gap, with the electrolyte solution containing the cells being located in the gap.

10. The method of claim 9, wherein the additional electrode is optically transparent electrode.

11. The method of claim 1, in which the electrode is patterned by spatially modulated oxide growth, surface chemical patterning or surface profiling, wherein said patterning modifies the spatial distribution of the interfacial electric field.

12. The method of claim 11, wherein the patterning step is used to create a plurality of areas of low impedance on the electrode, and the illumination step is used to selectively connect one or more of the areas of low impedance, thereby causing the cells to move therebetween in accordance with the patterning and the predetermined light pattern.

13. The method of claim 1, wherein the illumination step comprises illuminating a selected area of the electrode, which in combination with the electric field, causes the cells to move into the selected area or out of the selected area.

14. The method of claim 1, wherein the illuminating step comprises illuminating the electrode with a predetermined light pattern to form a lateral gradient in the electrochemical properties of the electrode to control the movement of the cells in accordance with the illumination pattern in a direction orthogonal to the direction of the applied electric field.

15. The method of claim 1, wherein the cells comprise eukaryotic or prokaryotic cells.

16. A method of manipulating cells suspended at an interface between an electrode and

an electrolyte solution, the method comprising the following steps:

providing a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane, an electrolyte solution located therebetween and a plurality of cells suspended at an interface between the electrolyte solution and the second electrode, wherein the second electrode comprises a planar electrode having a surface and an interior, the surface or interior having been modified to produce spatial modulations affecting the local distribution of the electric field at the surface of the electrode; and

generating an electric field between the first and the second electrode by applying a voltage between the two electrodes to control the movement of the cells in accordance with the spatial modulations of the properties of the second electrode.

17. The method of claim 16, wherein the properties of the electrode comprise impedance or surface charge depositing.

18. The method of claim 16, wherein the spatial modulation of the properties of the second electrode is carried out by modifying the surface or the interior of the second electrode by spatially modulated oxide growth, surface chemical patterning or surface profiling.

19. The method of claim 16, wherein the second electrode comprises a silicon electrode coated with a dielectric layer.

20. The method of claim 16, wherein the first electrode comprises a planar electrode, with the first electrode and the second electrode being substantially planar and parallel to one another and separated by a gap, with the electrolyte solution containing the cells being located in the gap.

21. The method of claim 21, wherein the first electrode comprises an optically transparent electrode.

22. The method of claim 16, wherein the properties of the second electrode being

modulated comprise impedance, with one or more areas of the surface or the interior of the second electrode being modified to exhibit low impedance, and wherein the movement of the cells is to areas of low impedance.

23. The method of claim 16, wherein the electric field is generated by applying an AC voltage between the first and the second electrode.

24. An apparatus for manipulating cells suspended at an interface between an electrode and an electrolyte solution, comprising:

a light-sensitive electrode and an electrolyte solution;

a means for generating an electric field at an interface between the electrode and the electrolyte solution; and

a means for illuminating the electrode.

25. An apparatus for manipulating cells suspended at an interface between an electrode and an electrolyte solution, comprising

a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane, the first and the second electrode each comprising a planar electrode and said electrodes being in a substantially parallel alignment,

a gap between the first and the second electrode, the gap being capable of containing an electrolyte solution in which a plurality of cells is suspended,

wherein the second electrode comprises a light-sensitive electrode,

and wherein the first and the second electrode are configured so that when a voltage is applied between the electrodes, with the electrolyte solution containing the cells located in the gap, an electric field is generated at an interface between the second electrode and the electrolyte solution,

the apparatus being capable of controlling movement of the cells at the interface between the second electrode and the electrolyte solution when the electric field is generated at the interface and the interface is illuminated with a predetermined light pattern.

26. The apparatus of claim 24 or 25, wherein the light-sensitive electrode comprises a silicon electrode which is coated with a dielectric layer.

27. The apparatus of claim 24 or 25, wherein the light-sensitive electrode is patterned by spatially modulated oxide growth, surface chemical patterning or surface profiling, wherein said patterning modifies the spatial distribution of the electric field at the interface.

28 The apparatus of claim 24 or 25, wherein the properties of the light-sensitive electrode comprise impedance.

29. The apparatus of claim 25, further comprising an electric field generator which generates an electric field the interface, and an illumination source which illuminates the interface.

30. The apparatus of claim 24 or 25, further comprising an electrolyte solution and a plurality of cells located at the interface.

31. An apparatus for manipulating the movement of cells suspended at an interface between an electrode and an electrolyte solution, comprising:

a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane, the first and the second electrode being substantially planar electrodes in parallel alignment;

a gap between the first and the second electrode, the gap being capable of containing an electrolyte solution in which a plurality of cells are suspended,

wherein the second electrode is patterned to modify its properties and wherein the first and the second electrode are configured so that an electric field is generated when a voltage is applied between the first and the second electrode, with the electrolyte solution containing the cells located in the gap, and wherein the patterning of the second electrode modifies its properties affecting the local distribution of the interfacial

electric field.

32. The apparatus of claim 31, wherein the second electrode is modified by spatially modulated oxide growth, surface chemical patterning or surface profiling.

33. The apparatus of claim 31, wherein the properties comprise impedance.

34. The apparatus of claim 31, wherein the second electrode comprises a silicon electrode which is coated with a dielectric layer.

35. A method of forming an assembly of cells into a designated area on a substrate, comprising:

providing a plurality of cells suspended at an interface between a light-sensitive electrode and an electrolyte solution;

generating an electric field at the interface; and

illuminating the interface with a predetermined light pattern to control the formation of a planar assembly of substantially one layer of cells in a designated area on the electrode, wherein the designated area is defined by the pattern of illumination.

36. The method of claim 35, in which the movement of the cells is controlled by the combination of the illumination and the electric field.

37. The method of claim 35, which provides an additional electrode, such that the additional electrode and the light-sensitive electrode being substantially planar and aligned to one another and separated by a gap, wherein the additional electrode comprises an optically transparent electrode.

38. The method of claim 35, further comprising modifying the electrode by spatially modulated oxide growth, surface chemical patterning or surface profiling.

39. The method of claim 35, further comprising the step of spatially or temporally varying the light pattern to cause the alteration of the assembly, said alteration

being selected from the group consisting of disassembly, disassembly followed by reassembly, repositioning of the assembly, reconfiguration of the assembly, and segmentation of the assembly.

40. The method of claim 35, further comprising the step of varying the frequency or the voltage of the electric field to cause the alteration of the assembly, said alteration being selected from the group consisting of disassembly, disassembly followed by reassembly, repositioning of the assembly, reconfiguration of the assembly, and segmentation of the assembly.

41. The method of claim 35, in which the plurality of cells comprises more than one type of cells, the method further comprising the step of fractionating one type of cells from another to induce a displacement of the plurality of cells within the assembly, fractionation arising as a result of differences in mobility of said types of cells.

42. The method of claim 35, further comprising the step of maintaining the cells in the assembly, wherein the maintenance step comprises maintaining the electric field and the predetermined light pattern, or immobilizing the cells by chemical or physical means.

43. The method of claim 42, in which the cellular assembly is immobilized on the electrode by chemically linking the cells or confining the cells.

44. A method of forming an assembly of cells in a designated area on a substrate, comprising:

providing a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane, an electrolyte solution located therebetween and a plurality of cells suspended at an interface between the electrolyte solution and the second electrode, wherein the second electrode comprises a planar electrode having a surface and an interior, the surface or interior having been modified to produce spatial modulations in properties of the second electrode; and

generating an electric field between the first and the second electrode by applying a voltage between the two electrodes, thereby forming a planar assembly of substantially one layer of cells in a designated area on the second electrode, wherein the designated area is defined by the spatial modulation affecting the local distribution of the electric field at the surface of the second electrode and the properties of the second electrode are those affecting the local distribution of the interfacial electric field.

45. The method of claim 44, wherein the properties being modulated comprise impedance or surface charge density.

46. The method of claim 44, wherein the properties being modulated comprise impedance, and the designated area comprising the area of lower impedance.

47. The method of claim 44, further comprising the step of maintaining the assembly of cells by maintaining the electric field or by immobilizing the cells by chemical or physical means.

48. The method of claim 44, in which the cellular assembly is immobilized on the electrode by chemically linking the cells or confining the cells.

49. The method of claim 44, in which the first electrode comprises a substantially planar, optically-transparent electrode.

50. The method of claim 49, further comprising the step of optically imaging the cells in the assembly.

51. The method of claim 50, in which the optical imaging step is performed to determine the morphology of the cells in the assembly.

52. The method of claim 50, in which the optical imaging step is performed to determine the size, shape or granularity of the cells in the assembly.

53. An assembly of cells formed in a designated area on a substrate, comprising a substrate; and a dynamically formed planar assembly of cells comprising substantially one layer of cells in a designated area on the substrate.

54. The assembly of claim 1, in which the designated area is defined by the electrochemical properties of the substrate.

55. An assembly of cells formed in a designated area on a substrate, comprising a substrate; and a planar assembly of cells comprising substantially one layer of cells in a designated area on the substrate, wherein the assembly is formed according to the method of claim 33.

56. An assembly of cells formed in a designated area on a substrate, comprising a substrate; and a planar assembly of cells comprising substantially one layer of cells in a designated area on the substrate, wherein the assembly is formed according to the method of claim 35 or 44.

57. The assembly of cells according to any one of claims 53 to 56, wherein the substrate comprises a silicon chip which is coated with a dielectric layer.

58. The assembly of any one of claims 53 to 56, wherein the assembly of cells, subsequent to being formed, is immobilized by chemical or physical means.

59. The assembly of claim 58, in which the cellular assembly is immobilized on the electrode by chemically linking the cells or confining the cells.

60. A method of conducting a bioassay involving an assembly of cells, comprising: providing a dynamically formed planar assembly of cells comprising substantially one layer of cells in a designated area on the substrate,

contacting the cells with an analyte; and

detecting the binding of the analyte to the cells.

61. A method of conducting a bioassay involving an assembly of cells, comprising:

providing a planar assembly of cells comprising substantially one layer of cells in a designated area on the substrate, wherein the assembly of the cells is formed according to the method of claim 35 or 44;

contacting the cells with an analyte; and

detecting the binding of the analyte to the cells.

62. The method of claim 60 or 61, in which the cells in the assembly of the cells are immobilized prior to contacting the cells with the analyte.

63. The method of claim 62, in which the cells are immobilized by chemically linking the cells or confining the cells.

64. The method of claim 60 or 61, in which the analyte is directed to a specific cellular marker, and the bioassay is for determining the presence of the cellular marker on the surface of the cells.

65. The method of claim 64, in which the bioassay is directed to cell typing, with the presence of the marker on the cell surface indicating the cell type.

66. The method of claim 64, wherein the analyte is attached to a label and the detection of the binding of the analyte to the cells is carried out by detecting the presence of the label.

67. The method of claim 64, further comprising the step of removing the analyte that is not bound to the cell before the detection step is carried out.

68. The method of claim 64, wherein the analyte is attached to a label, said label comprising a flourescent tag.

69. The method of claim 64, wherein the analyte is attached to a label, said label comprising a bead which is distinguishable by chemical or physical characteristics.

70. The method of claim 64, in which more than one analyte is tested simultaneously for binding with the cells, with each analyte being attached to an encoded bead that is distinguishable by chemical or physical characteristics, and the detecting step comprising decoding the beads bound to the cells to determine the respective identities of analytes bound to the cells.

71. The method of claim 64, wherein the analyte is a ligand directed to a specific cellular receptor and the bioassay is for determining the presence of the receptor on the surface of the cells.

72. The method of claim 64, wherein the analyte is an antibody directed to a specific cellular antigen, and the bioassay is for determining the presence of the antigen on the surface of the cells.

73. The method of claim 64, in which the presence of more than one antigen is determined using more than one antibody, wherein each antibody is attached to a fluorophore tag that is chemically distinguishable, wherein the detection step comprises multicolor imaging of the cells.

74. A method of assaying the binding of cells with a ligand or an antibody, said method involving a planar assembly of cells and comprising:

providing an assembly of cells prepared according to claim 35 or 44, wherein the assembly further comprises a plurality of encoded beads randomly mixed with the cells in the designated are, each bead displaying on its surface a ligand or an antibody, the code of each bead uniquely corresponding to the ligand or the antibody on its surface, the proximity of the cells with the ligand or the antibody allowing the binding interaction therebetween,

disassembling the mixed assembly of the cells and the encoded beads; and

detecting the binding interaction by analyzing the formation of clusters composed of the cells and the encoded beads, the binding indicating the presence or absence of a cellular receptor or an antigen specific for the ligand or the antibody.

75. The method of claim 1, further comprising providing a planar array of encoded beads immobilized on the light-sensitive electrode, said array comprising substantially one layer of the encoded beads in a substantially non-random spatial arrangement and each bead displaying on its surface a ligand or an antibody, wherein the cells are moved across the array of beads, allowing the binding interaction to occur between ligand or the antibody and the cells, and detecting the binding by identifying the selective adhesion of the cells to beads in the array, with the binding indicating the presence or absence of a cellular receptor or an antigen specific for the ligand or the antibody.

76. The method of claim 73 or 74, in which more than one ligand or antibody is used, with each being attached to an encoded bead that is distinguishable by chemical or physical characteristics.

77. A method of detecting a cellular response to an analyte, the method involving an assembly of cells and comprising:

providing a dynamically formed planar assembly of cells comprising substantially one layer of cells in a designated area on the substrate;

contacting the cells with an analyte; and

detecting a cellular response to the analyte.

78. A method of determining a cellular response to an analyte, the method involving an assembly of cells and comprising: providing a planar assembly of cells formed according to claim 55 or 56; contacting the cells with an analyte; and detecting a cellular response to the analyte.

79. The method of claim 77 or 78, wherein one or more analytes are being tested for its ability to induce the cells to secrete one or more biologically active substances, and

the detection step comprises detecting the presence of the biologically active substances.

80. The method of claim of 79, wherein the biologically active substance comprises cytokine.

81. A method of determining a cellular response to an analyte, the method comprising:
providing the apparatus according to claim 25 or 31;
providing a planar array of encoded beads on the first electrode, each bead displaying a ligand on its surface and uniquely identifying the ligand, said ligand being attached to the bead in a releasable manner;
providing a planar assembly of the cells on the second electrode, with the gap area separating the encoded beads from the assembled cells; and
releasing the ligand and monitoring a cellular response, the proximity of the cells to the bead array permitting determination of the identity of the ligand inducing the cellular response.

82. The method of claim 77 or 78 , wherein the analyte comprises a drug molecule or a ligand.

83. The method of claim 77 or 78 , in which the cellular response being detected is an expression of a particular gene, said expression being determined by detecting for the presence of an intracellular reporter gene product.

84. The method of claim 83, in which the expression of the intracellular reporter gene yields intracellular fluorescence.

85. The method of claim 77 or 78, in which the cellular response being detected is selected from the group consisting of: morphological change of the cells, change in the cell membrane permeability, and a change in the chemiotaxis response by monitoring the movement of cells.

86. A method of determining the interaction between cells, comprising:

providing an apparatus of claim 25 or 31, in which the electrolyte solution containing at least one type of cell is located in said gap;

introducing at least one cell of second type into the electrolyte solution and allowing the cell of the first type and the cell of the second type to interact;

generating an electric field at the interface to move the cells into a designated area on the second electrode; and detecting the interaction between the two cell types by ascertaining the formation of clusters.

87. A method of determining the interaction between cells, comprising:

providing an apparatus of claim 25 or 31, in which the electrolyte solution contains at least one cell of a first cell type;

generating an electric field at the interface to move the cell of the first type into a designated area on the second electrode;

introducing at least one cell of a second type into the electrolyte solution, and moving said cell to the designated area on the second electrode in which the first cell type is located, thereby allowing the interaction between the two cell types to occur; and

detecting the interaction.

88. A method of determining the interaction between cells, comprising:

providing an apparatus of claim 25 or 31, in which the electrolyte solution contains at least one cell of a first cell type and one cell of a second cell type, each cell type being located in a different designated area on the second electrode;

generating an electric field at the interface to move the cell of the first type into a designated area occupied by the cell of the second type, thereby allowing the interaction between the different cell types to occur; and

detecting the interaction.

89. The method according to any one of claims 86-88, in which the interaction between the cell types is detected by a method selected from the group consisting of: detecting a morphological change of cells, detecting a change in a cell surface marker by use of a ligand or an antibody; detecting a change in a protein

expression, detecting a change in the RNA level, detecting a change in cell permeability, and by detecting adhesion of cells.

90. The method of claim 86 or 88, in which the detection measure pertains to determining a change in the protein expression or RNA changes, wherein the cells are fixed after the changes to assist detection.

91. A method of conducting a bioassay involving an assembly of cells, comprising:

providing an apparatus of claim 25 or 31, in which the electrolyte solution containing a plurality of cells is located in the gap area;

introducing at least one analyte into the electrolyte solution, and allowing the binding interaction to occur between the analyte and the cells;

forming an assembly of the cells in a designated are on the light-sensitive electrode; and

detecting the binding between the analyte and the cells.

92. A method of detecting a cellular response to an analyte, the method involving an assembly of cells and comprising:

providing an apparatus of claim 25 or 31, in which the electrolyte solution containing a plurality of cells is located in the gap area;

introducing at least one analyte into the electrolyte solution and allowing the interaction to occur between the analyte and the cells;

forming an assembly of the cells in a designated are on the light-sensitive elcctrode; and

detecting a cellular response to the analyte.

93. The method of claim 91 or 92, wherein the interaction between the cells and the analyte occur before the formation of the assembly.

94. The method of claim 92, in which the analyte comprises an antibody or a ligand.

95. An apparatus for conducting a bioassay, comprising:

a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane, the first and the second electrode each comprising a planar electrode and said electrodes being in a substantially parallel alignment,

a gap between the first and the second electrode, the gap being capable of containing an electrolyte solution in which a plurality of cells are suspended;

wherein the second electrode comprises a light-sensitive electrode,

and wherein the first and the second electrode are configured so that when a voltage is applied between the electrodes, with the electrolyte solution in the gap, an electric field is generated at an interface between the second electrode and the electrolyte solution,

a means for introducing one or more analytes or cells into the gap; and

a means for detecting the interaction between the analyte and the cells, or between the different types of cells,

the apparatus being capable of controlling movement of the cells at the interface between the second electrode and the electrolyte solution when the electric field is generated at the interface and the interface is illuminated with a predetermined light pattern.

96. An apparatus for manipulating the movement of cells suspended at an interface between an electrode and an electrolyte solution, comprising:

a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane, the first and the second electrode each comprising a planar electrode and being in substantially parallel alignment;

a gap between the first and the second electrode, the gap being capable of containing an electrolyte solution in which a plurality of cells are suspended, wherein the second electrode is patterned to modify its properties and wherein the first and the second electrode are configured so that an electric field is generated when a voltage is applied between the first and the second electrode, with the electrolyte solution containing the cells located in the gap, and wherein the patterning of the second electrode modifies its properties affecting the local distribution of the interfacial electric field;

a means for introducing one or more analytes into the gap; and

a means for detecting the interaction between the analytess and the cells, or between different types of cells.